Modularity, Relativism, and Neural Constructivism

Josefa Toribio

School of Cognitive and Computing Sciences
University of Sussex [1]

Fodor (1983) claims that the modularity of mind (the relatively encapsulated, insulated, special-purpose nature of the psychological mechanisms of perception) helps undermine relativism in various forms. I shall show first, that the modular vision of mind provides insufficient support for the rejection of (most forms of) relativism, and second, that an alternative ('neural constructivist') model may, in fact, provide a better empirical response to the relativist challenge.

Keywords: encapsulation, modularity, neural-constructivism, perception, plasticity, relativism

Introduction

Fodor (1983) defends a model of cognitive architecture in which there is a profound difference between perceptual processes and higher order cognitive processes — between processes underlying sensory experience and those involved in problem solving, decision making, inference and reflective thought. Contrary to models of cognition in which the continuity of these two types of processes is assumed, Fodor's main thesis is that the psychological mechanisms involved in perception are *encapsulated*, i.e., they consist in a variety of computational modules whose operations don't have access to the information stored by each other or by the system's central processing mechanisms. Such modules are autonomous, innately specified, and specific to their particular domains. Their outputs feed into — but not from — cognitive processes underlying higher cognitive faculties. As a result the flow of information is organized in a bottom-to-top fashion. Unlike perceptual modules however, the mechanisms underlying higher cognitive processes are characterized by the complete absence of encapsulation. Central systems can operate on the basis of information contained in any module, and are

[1] Address for correspondence: Josefa Toribio. School of Cognitive and Computing Sciences. University of Sussex. Falmer. Brighton BN1 9QH. England. UK. Email: pepat@cogs.susx.ac.uk.

"characterized by computations in which information flows every which way" (Fodor, 1985, p. 4).

There are other characteristics that help sharpen the distinction between perception and higher-level cognition, but they are not my concern in this paper. The issue I shall address is the plausibility of the deep parallelism that Fodor claims exists between interactionist models of mind and general relativist theses. It is this putative parallelism that drives much of Fodor's thought. We read, for example, that:

> "The idea that cognition saturates perception belongs with (and is, indeed, historically connected with) the idea in the philosophy of science that one's observations are comprehensively determined by one's theories; with the idea in anthropology that one's values are comprehensively determined by one's culture; with the idea in sociology that one's epistemic commitments, including especially one's science, are comprehensively determined by one's class affiliations; and with the idea in linguistics that one's metaphysics is comprehensively determined by one's syntax. All these ideas imply a sort of relativistic holism [in which] perception is saturated by cognition, observation by theory, values by culture, science by class, and metaphysics by language ...
>
> The thing is: I *hate* relativism ... More to the point, I think that relativism is very probably false. What it overlooks, to put it briefly and crudely, is the fixed structure of human nature."(Fodor, 1985, p. 5).

One of the most important philosophical consequences of the modularity thesis is, according to Fodor, that we can use it as an argument against global relativist positions. In other words, if it turns out to be true that our cognitive architecture involves perceptual cognitive modules which unidirectionally feed information about the world into a more flexible but still fixed, i.e., genetically determined, central system, then we have — Fodor claims — a new tool to combat relativism.

The main goal of this paper is to analyze in more detail this alleged relationship between modularity and relativism. In Section 1 I introduce some basic varieties of relativism. The purpose of this section is to get a better understanding of the kind of position that Fodor hopes to refute *via* the modularity hypothesis. In Section 2 I address the question of whether the encapsulation of perceptual processes guarantees the non-relativist character of our perceptions. I argue that this is doubtful, but that even if we assume that it does (for the sake of the argument), a more important problem remains, viz., whether such encapsulated perceptions can themselves guarantee the non-relativist nature of conceptual apprehension and judgment. Section 3 introduces an alternative (neural-constructivist) model of cognition. This model — unlike Fodor's modularity hypothesis — depicts the modular structure of the brain not as the starting point of our cognitive development but rather as the end result of an experience-dependent period of neural growth. This dynamic interaction between environmentally dependent neural activity and developmental mechanisms actually lends better support — I finally argue — to a broadly anti-relativist view of how our brains represent the world.

1. Varieties of relativism

It is important to begin by drawing certain distinctions among the varieties of relativism. Relativist views share, as Fodor notes, a common flavor. But there remain enough differences to warrant some more fine-grained classification. It is common, for example, to divide relativist theses into metaphysical, epistemological and semantic subspecies. These varieties can be roughly characterized as follows:

i) Metaphysical Relativism: The claim that what there is, whatever exists — e.g., medium-sized objects, facts, theoretical entities, etc. — exists only within the framework of a particular subject, community, or theory.

ii) Epistemological Relativism: That claim that what we believe and what we know is relative to a person, a culture or a particular framework of reasoning.

iii) Semantic Relativism: The claim that the truth of our statements is relative with respect to subjects, communities, languages or particular theories.

In general, and despite the need for some qualifications (see below), it is proper to characterize all these relativist theses as being opposed to some realist ones. The reasons become apparent if we consider the most fundamental kinds of realist claims. The metaphysical realist maintains that there is an objective world, 'objective' in the sense of being constituted by objects and properties which are what they are independently of the knowledge we have about them and independently of the cognitive resources available to us to achieve such knowledge. The existence of these objects and properties is thus absolutely fixed and independent of any epistemic considerations; it is completely independent of our mental activity, our practices and our background beliefs. The epistemological aspect of such realism is often formulated as the claim that the objects and properties that constitute the world are capable of being known by us as they really are. Subjects have access to the world in which they live and are capable of obtaining objective information about it. If we add to these claims one more component, namely, the idea that science is the enterprise that allows us to have epistemic access to this independent reality and that, therefore, the entities postulated by scientific theories have the same ontological status as any other non-theoretical entities — even when they lie beyond our observational capabilities —, then we arrive at the position usually called ‘scientific realism’.

Now, some of these varieties of relativism are compatible with some of these types of realism. To mention just one case, some sociologists of science believe that there is an independent social reality to which their theories apply, but they also maintain that there is no theory or scientific method which can be justifiably accepted as the true one. These sociologists are, in other words, realists at the metaphysical level, but relativists at the epistemological or methodological level. The basic idea here, as elaborated by Kuhn (1962) and Feyerabend (1975), is that there is always incommensurability at the observational level, i.e., that genuinely different theories about the same realm of reality can be compatible and can explain all the relevant data.

However, Fodor’s use of the term ‘relativism’ is insensitive to these distinctions and tries to encompass all three varieties mentioned above without qualifications or refinements. Fodor’s position can be formulated as follows: if modular perceptual processes provide us with theory-neutral access to reality, then our epistemic situation is much as it was imagined to be in the good old days before Kuhn and Feyerabend. The observation-based ontology with which we work is not just one among different alternatives all of which are compatible with our perceptual apparatus. Not only that, the reference of our observational terms is univocally determined and the truth value of the sentences in which they occur doesn’t change as a function of the different theoretical frameworks to which those terms belong. Fodor’s fundamental thesis thus has the form of a conditional: if the modularity hypothesis is correct, our cognitive architecture itself constitutes a sufficient reason to reject all the varieties of relativism (ontological, epistemological, and semantic).

There are many questions that one might ask regarding such a broad and controversial claim. The first is whether Fodor’s modularity hypothesis can indeed guarantee the existence even of theoretically neutral perceptual representations. Even if it did, a further issue remains to be addressed, namely, whether such neutral perceptions really support a non-relativist view at the level of conceptual discourse, i.e., the kind of discourse in which we express our judgments and theories. I shall address both these topics in the next section (Section 2). A further question is how plausible, *qua* scientific hypothesis, is the modularity thesis itself. In Section 3 some evidence is presented to support a rather different (‘neural constructivist’) view of our cognitive architecture, one where modularity is not considered the beginning of our cognitive life but rather (at most) the end result of complex developmental interactions between brains and the environments in which they are embedded. I argue that this alternative neuro-constructivist hypothesis actually provides better reasons (than does Fodor's modularity hypothesis) for skepticism concerning strongly relativist views of certain kinds.

2. Process and product

In order to discuss Fodor's idea that the encapsulated character of our perceptual processes provides support for a non-relativist view of perceptual representations, I would like to introduce a distinction between *processing* and *product*. It seems intuitively plausible to accept that the properties that can be appropriately ascribed to the processing of something don't necessarily have to be ascribed to the outcome or the product of such processing. The properties that are truly predicated of e.g. the processes involved in photo developing are not the same as (although they can be related to) the properties predicated of the final result, namely, the photographs themselves.

To make this clearer, consider the domain of speech perception. When the users of a language speak, they don't do so by maintaining a steady rhythm or delivering the words or sentences they utter at a constant speed. Speakers often slow down or accelerate the rhythm of phoneme production. This variation in speed of speech can be quite dramatic. The average duration of a syllable, for instance, can vary hundreds of milliseconds in a single conversation. At the level of speech processing, the acoustic properties that specify and determine the identity of phonetic fragments have a temporal character and are modified by speed and rhythm. However, if we pay attention to the outcome of that processing, i.e., if we focus on the phonetic segments of an utterance, what we find is a *constant* phonetic structure, a fixed structure that has already incorporated the speed at which the utterance was produced (Miller, 1987).

What this and other cases of perceptual representation suggests is that the properties of perceptual processing don't necessarily have to be shared by the properties of the *outcome* of such processing, i.e., by perceptual representations. Therefore, even if we assume that the property of being encapsulated obtains at the level of perceptual processing, that doesn't necessarily guarantee the encapsulated character of the products of such processing, i.e., the encapsulated character of our perceptual representations. Since, according to Fodor, being encapsulated — and hence immune to 'top-down revision' — is the key to blocking perceptual relativism, the proper conclusion is just that the mechanisms involved in the *processing* leading to perceptual representations is *fixed* for a given species and a given domain. However, from this (much weaker) claim, nothing much follows regarding the character of the perceptual representations themselves.

Now, it could be argued that Fodor's own notion of encapsulation leaves open the possibility of communicating in a restricted way by means of an interface:

> ".. the representations that input systems deliver have to interface somewhere, and the computational mechanisms that effect the inter-

face must ipso facto have access to information from more than one cognitive domain." (Fodor, 1983, pp. 101-102).

The question is: what may thus be communicated? The answer again does not seem to help Fodor block the threat of relativism at the level of the *product* of perception. In order to see why, let's re-visit some of Fodor's considerations regarding the nature of the architectural relationships that support exchanges of information between input systems and central systems.

To begin with, it might be useful to remember that underlying Fodor's argument there is one important assumption that he takes for granted: "the mechanisms that interface between vertical faculties have to be computational rather than, as one might say, merely mechanical" (Fodor, 1983, p. 138, fn. 37). This is because the perceptual inferences which lead to perceptual representations are typically *nondemonstrative* and therefore subject to the realization of a confirmation function. But "the confirmation function for input systems does not have access to all of the information that the organism internally represents" (Fodor, 1983, p. 69).

In other words — and using the previous example —, what is *communicated* by speech processing mechanisms are acoustic properties such as speed of phonemes, but the confirmation function that determines the phonetic segments of an utterance are encapsulated with respect to any other *non*-phonetic information. The information required for e.g. the determination of the lexical structure of a phonetic segment may be internally represented and accessible to other cognitive processes, but the mechanisms that effect this kind of interface between phonetic and lexical determination are not themselves encapsulated and therefore, according to Fodor, they belong to the central system.

So, it is indeed true that there must be same kind of exchange of information between perceptual representations which are the result of domain-specific perceptual *processing* and some other representations, but such exchange of information between perception and — what Fodor calls — *utilities* occurs *after* the domain-specific perceptual representations have been determined, and involves "simultaneous results of input analysis in other domains" (Fodor, 1983, p. 102). All this supports our claim that encapsulation *during* perceptual integration — even allowing for the possibility of restricted communication *via* an interface — does not imply encapsulation of the mechanisms involved in the determination of the final cognitive product.

But suppose we grant, just for the sake of argument, that encapsulation at the processing level somehow guarantees encapsulation at the level of the cognitive product. What follows? Unfortunately, still not much. For judgments and beliefs can be considered (epistemically) neutral if and only if their truth doesn't depend on the truth of a particular psychological or theoretical framework. But, as Paul Churchland has very elaborately argued "a rigidity in our early perceptual processing is entirely consistent with plasticity at the level of conceptual apprehension and discursive judgment" (Churchland, 1988, p. 170; see also Churchland, 1989, chapter 9)[2]. In other words, even 'neutral' perceptual representations can still be interpreted differently against the background of different theoretical frameworks. Regardless of how encapsulated perceptual representations themselves might be, the correspondences that could be established between them and the domain of theoretical propositions (judgments, beliefs, etc.) remain many. Yet it is, surely, the higher-level relativisms of belief and judgment that Fodor is most concerned to avoid.

Fodor himself admits, of course, that once we ascend to the level of central processing, encapsulation disappears. But central processing, for Fodor, itself constitutes a fixed, non-plastic system, one that is largely innate and not susceptible to deep architectural modification by environmental inputs. The internal consistency of Fodor's view thus depends, I believe, upon not just the encapsulated character of perceptual processing, nor even the encapsulated character of the perceptual representations themselves, but also on the *innate* and *fixed* structure of the basic central cognitive architecture with which we are endowed. It is this additional dimension of evolutionarily determined fixity that limits the freedom of even central processing in interpreting and assimilating the deliverances of the perceptual modules (see Fodor, 1994, chapter 4).

3. Neural constructivism, and an alternative response to relativism

Consider next the emerging view known as *neural-constructivism*. I shall first introduce the main features of this view, and then show how it bears on the issues concerning modularity, relativism, and cognitive architecture.

'Neural-Constructivism' names a body of recent research regarding the relation between neural activity and developmental change. Two major claims of the neural-constructivist movement are: a) that cognitive (including cortical) development involves the experience-dependent construction of *new* neural mechanisms (not just the maturation or tuning of already established ones), and b) that these mechanisms result from a dynamic interaction between the environment in which the agent is embedded and the agent's existing neural architecture. Modularization is depicted as the endpoint of a long dynamic process in which learning experiences affect the very neural mechanisms involved in perception, thought, and experience.

---

[2] Fodor himself has (slightly) modified his views regarding the modularity thesis in response to the objections presented by philosophers like Paul Churchland (cf. Fodor, 1988). However, even in his modified version, the relationships between modularity and (anti)relativism remain pretty much as characterized in this paper.

Consider the visual system of babies and young infants. Approximately 1 in 10,000 babies are born with congenital cataracts (Sireteanu, 1999). This condition, if untreated in infancy, prevents the children from ever developing normal vision — even if the condition is diagnosed and treated later in life. The lack of proper visual inputs at these very early stages, according to the neural-constructivist, inhibits the growth of new neurons in the visual cortex and the development of the necessary connections to enable the children to see properly. Sireteanu reports a study (Maurer et. al., 1999) which shows the high plasticity of infants' brains through a quite simple psychophysical test. The study was designed to assess the visual acuity of 28 human infants who were deprived of all patterned visual input by congenital cataracts in one or both eyes until they were treated at one week to nine months of age. The treatment consisted in the surgical removal of the cataracts and — after a certain period of recovery — the implantation of contact lenses. Only after the implantation of the lenses could visual input be focused on the retina. The test consisted in the measurement of visual acuity by exposure to objects containing clear patterns, such as black and white stripes. The results show that visual acuity does not improve postnatally until the nervous system receives patterned visual input. However, once treated, exposure to patterned visual input has a great and rapid impact upon the nervous system that results in improved acuity even as early as one hour after visual exposure to the test patterns! What this and other similar studies (e.g. Klinke, 1999)[3] are claimed to show is not only the great plasticity of the infants' brain, but also the importance of early sensory input for shaping the neural structures that contribute to later development.

The key neural constructivist claim is thus that, whether internally generated or prompted by external factors, neural activity at the cortical level plays an essential role, not just in selecting fixed neural mechanisms, but also in actually *constructing* new cortical circuits. This kind of constructive plasticity has lead some researchers (see e.g. O'Leary 1989, 1997) to talk about the cortex in young infants as *proto-cortex*, as a kind of neural architecture that needs both the input of other regions in the brain and also experience-derived afferent inputs to become differentiated and domain specific. These types of input affect not only the function of cortical regions, but also their structure.

There is a sense, of course, in which the neural-constructivist paradigm is not *really* such a new approach. Plasticity of orientation-sensitive neurons in the cat's LGN was, for example, demonstrated back in the late fifties and

[3] Klinke and his collaborators fitted congenitally deaf kittens with cochlear implants. The implants transmit acoustic signals directly into the brain thus bypassing the damaged inner ear. After that, the area of the auditory cortex is re-structured by new neural responses and higher synaptic efficacy which, in turn, improve the kittens' auditory capabilities.

early sixties (cf. Held & Hein, 1958, 1963)[4]. But, although that's surely true, the kind of neural plasticity shown by those studies was not — as it is in the case of the current neural-constructivist view — *cortical* plasticity. The idea of an interesting dynamic interaction between internal properties of the brain and environmental inputs was already there, but such interaction was demonstrated only in areas of the brain such as LGN. The contemporary neural-constructivist adds a new layer of complexity to those previous results by positing neural plasticity, not only at the peripheral level, but also at the cortical heart of 'higher level cognition' (cf. Schlagger & O'Leary, 1991; Roe, et. al, 1992).

The neural constructivist model thus depicts a hierarchical experience-dependent constructive development of prefrontal cortex. It is hierarchical because the patterns of cortical development re-organize themselves in an *upward* fashion, from the sensory periphery — especially primary sensory and motor cortical areas which mature very soon after birth — to higher and higher association areas. Cortical plasticity thus reaches deep into what Fodor calls 'central processing'. The process is constructive because development does not consist just in the maturation of the cortical layers, but rather in the re-structuring of the cortical topology itself The prefrontal cortex — the part of the brain involved in higher cognitive capacities such as the temporal organization of action, working memory, and inferential reasoning — seems to be built upon a cascade of increasingly complex re-organizations of representational structures whose development depends, in turn, on the development of other, more peripheral neural circuits: "PFC [pre-frontal cortex] appears to be the latest cortical structure to mature and also to undergo the greatest post natal development" (Quartz, 1999, p. 54).

The neural constructivist approach thus constitutes a radical challenge to traditional views of cognitive architecture and accounts of neural maturation. The traditional image of *fixed* neural mechanisms underlying processes of learning and biological processes of maturation is rejected in favor of a different model according to which learning processes may alter the cognitive architecture itself — both at the level of perceptual modules and deeper processing structures. It is important to notice that — unlike selectionist and nativist models — one of the consequences of the constructivist approach is that learning no longer consists in searching through a *fixed*, pre-established hypothesis space. Rather, the structures already present in different problem-domains impose constraints on what can be learnt, and what is learnt affects the very architectures that support future learning.

This neural-constructivist model suggests a highly plastic mind, one responsive to the dynamic interaction between internal properties of the brain and experience-dependent neural activity. *If* it is true, it seems that we are

[4] Thanks to Gerhard Strube for pointing this out to me.

much more influenced by the changing features and structures of our environment, even at the level of the cognitive architecture itself, than was once believed. Such gross plasticity may seem to invite, at least *prima facie*, precisely the kind of relativist view that Fodor hates so much. But this is a mistake. In fact, the neural constructivist picture lends itself nicely to a defense of realism.

Thus recall the photographic analogy used (in Section 2) to distinguish between processing and product, and consider now the potential role of radical internal re-structuring in the veridical capture of whatever lies in front of the lens. Even if the most peripheral mechanisms of the camera (lens aperture, etc.) automatically adjust to the environmental conditions in which the *scene* we want to capture is taking place, it would surely be better still if the central mechanisms of our camera could also adjust to external conditions by e.g. reconfiguring the central hardware according to need or use (sports photography, aerial photography, portraiture, etc.).

Similarly, in many types of environment, biological organisms which are able to engage in input-driven processes of deep self re-design will have increased chances of survival and reproduction. In such processes of constructive learning, the internal mechanisms underlying different kinds of learning themselves get modified in ways likely to lead, in the kind of environment actually encountered, to more accurate perceptions of the salient features of that environment. (It is true that different training environments might thus promote the development of quite different *central* conceptual resources. But by allowing neurological plasticity to play an important role in the constitution of our central cognitive capabilities, what we thus invite (and encourage) is not a relativist so much as a more pluralist epistemology and metaphysics).

The anti-relativist grail, after all, is just to show how the actual environment surrounding the cognitive subject can become conceptualized in some *objective* way — and what this requires, empirically, is a realism-friendly account of the subject's conceptual development and conceptual deployment. We need such an account because we want the story about our psychological nature to comport with the plausible conviction that much of our knowledge accurately reflects our interactions with an independent world. We want our psychological profile to explain how it is possible for the world to become knowable and for our thoughts to become genuinely world-engaged.

Neural constructivism hypothesizes a psychological profile that lends considerable support to this realist project. For it suggests that human brains evolved precisely as engines of environmentally-driven plasticity. Such plasticity allows for the early, experience-driven, development of relatively encapsulated perceptual modules, but adds into the equation the subsequent, still experience-driven (but now filtered via those modules) development of more central cortical structures. The final image is thus of a whole processing system — from sensory modules through central processing — whose biases and strategies reflect actual interactions with the surrounding environment. This image, I contend, retains all the anti-relativist appeal of Fodor's fixed-module account, and affords the harmonization with central processing necessary (see Section 2) to secure objectivity at the level of conceptual thought and judgment. Indeed, the neural constructivist account may be preferred even as regards the perceptual modules alone, since it ties such modules not to some distant ancestral environment, but directly to the kinds of patterned input encountered in the actual (early) environment.

Recall, finally, the various forms of relativism identified in Section 1, viz., metaphysical, epistemological, and semantic. How might neural-constructivism impact these three different varieties? Let's start with metaphysical relativism. In principle, it might be argued that a neuro-constructivist perspective on cognition supports, rather than neutralizes, the idea that what exists, exists only relative to the framework of a particular thinker, community, or theory. However, the deep cognitive plasticity posited by the neural-constructivist can actually warrant a more realist view of how the world is, *precisely* by allowing the environmental and social interactions of biological organisms with their actual environments to dynamically re-design their cognitive architecture. The key concept here is one of *dynamical re-structuring*. Our cognitive architectures, rather than imposing a particular — and subject, community, or theory-variant — structure upon an unstructured world are open to a constant and sensitive re-negotiation so as to better reflect both our actual needs and projects and the (real) structures and opportunities provided by our actual environment. Such dynamic feedback promotes, rather than rules out, a more *accurate* partitioning of the world.

What about epistemological and semantic relativism? As we saw, the neural-constructivist model of cognition stresses the influence of the biological organism's environment even at the level of its own cognitive architecture. Doesn't this lead to a rather strong epistemological and semantic relativism? Think, for instance, about the strongest possible case of plasticity of cognitive mechanisms, namely, plasticity induced by the interactions between the biological organism and its fellow organisms and their culture. It may seem rather likely that the resulting mechanisms are *relative* to the community in which the organism grows up and that this, in turn, threatens the idea that the mechanisms developed *truly* represent the environment in an *objective* way[5].

To address this issue, let me briefly introduce some very interesting empirical results about categorization in olfaction and audition (Dubois, 2000).

5 Thanks to one of the referees of this paper for pointing out this special risk to me.

The research was performed using a set of different psychological experiments. In the case of olfactory stimuli, the experiments consisted in presenting the subjects (two groups of 40 people) with a sample of 16 familiar odors. Subjects were then asked to sort these odors and invited to comment on each category. Categories were constructed according to an empirical measure of similarity based on the number of subjects that located any given pair of odors within the same class (Dubois, 2000, p.39). The experiments on acoustic stimuli followed roughly the same pattern. This time 15 subjects were asked to sort out a set of 25 domestic noises (such as an alarm going off, a door closing, a nail clipper in action, etc.) in order to apply the same kind of algorithm for categorization as in the case of odors.

The experiments, in both cases, were also designed to shed light on the relationships between the cognitive representation of these odors and noises and their linguistic verbalization. I shall not comment here on the linguistic side of this research. What interests me about this study is the cognitive status of subjects' representations of the olfactory and acoustic stimuli. Regarding this particular aspect, the study shows, among other things, that — unlike visual inputs — odors and noises (as opposed to sounds[6]) are usually processed and represented as the effect of a particular source or a particular event on the perceiver, and thus do not have the same kind of objective status as visual objects do:

> "The experiments on odors and noises lead to the idea that .... the general process of categorization operates on the relations between the subject and the world, through the diversity of interactions subjects can have with the world. It is therefore the subjects' activities that structure their relations to the world, and hence their knowledge of the world, from which it follows that types of categories differ according to the different types of relations the subjects have to the world. Hence, the simple opposition of an 'object' in the world being faced by a 'subject' considered as an 'information processing system' becomes problematic on both sides." (Dubois, 2000, p. 59).

The quote is long, but it nicely illustrates why constructive plasticity at the cortical level need pose no threat to the idea that the resulting re-structured cortical topology represents the environment in an objective way. Such a threat would be *real* only if the view of an organism's mental representations being objective depended on their being determined quite independently of the organism's general interactions with its environment. But this view, as

[6] The acoustic phenomena are characterized as 'sounds' when there is no source or identifiable event that can be linked to them. Unlike noises, sounds are processed on the basis of physical parameters, i.e., by parameters which belong more clearly to the *objective* world. Linguistic analyses of the lexicon used to refer to these two types of phenomena also reflect this difference (cf. Dubois, 2000, p. 54)

Dubois' research helps illustrate, has little to recommend it. His analysis of odors and noises shows that the idea of a *correct* categorization of a particular stimulus encompasses not only olfactory or acoustic physical parameters which have been determined within the natural sciences, but also — and essentially — the organism's own activities.

Fodor's fear of relativism, we recall, was the fear of *wishful thinking* impregnating our perceptual experiences, and the fear of *wishful theorizing* polluting our experimental results. But the thesis that there exists an intimate and dynamical relationship between mind and world is not, on its own, *that kind* of relativist thesis. Instead, it displays brains and environment as cooperating to create a cognitive architecture better suited to negotiating the actual world, and thus opens the door to neither of Fodor's twin demons.

In sum, a neural-constructivist view of our cognitive capabilities provides a theoretical framework *better* able to take into account the dynamic interactions between environment and cognitive architecture and thus better able to account for the objectivity of high-level thought and reason. The idea of neural plasticity playing an essential role in the construction of new cortical circuits also offers a new way of looking at evolutionary psychology[7] and at the relationships between biological and cultural evolution. The cognitive landscape that the neural constructivist is beginning to sketch looks like a promising terrain where neuroscientists, biologists, psychologists, and philosophers may find interesting tools, not only for addressing questions regarding relativism, but also for more general inquiries regarding the biological basis of cognition.

4. Conclusions: Shopping around

Here is one way to view the present argument. Fodor (1985) offers the presence of evolutionarily tuned perceptual modules as a talisman against relativism. But the magic is weak, since the *products* of the perceptual processing, and the way they are *taken* (categorized and used) by central processing are what really matters to conceptual thought and judgment. Fodor is unmoved by this worry, perhaps because he *also* depicts central processing as deploying concepts and strategies which are largely fixed and innate (see Fodor, 1981). Such widespread fixity suggests, however, a rather stagnant cognizer, whose take on reality is surprisingly immune to the actual environmental inputs they receive. This is hardly ideal, given the realist goal of keeping us in touch with the way things really are around us. A more convivial empirical picture, for the realist, is offered — it was suggested — by

[7] Briefly, the neural constructivist sees the mind not as a fixed resource shaped by ancestral history but as (for the best part) a thoroughly plastic resource open to profound sculpting by early learning.

the emerging research program known as neural-constructivism. Human cognitive architecture, according to the neural constructivist, is persistently plastic at many levels, with early systemic inputs determining both details of perceptual modular organization and — a little later — of deep cortical specialization. This cascade of input-sensitive plasticity preserves the attractions of Fodor's fixed-module story, allowing perceptual processing to be relatively encapsulated and immune to top-level tinkering. But it simultaneously allows details of central processing and deep cognitive architecture to be affected by actual environmental inputs, and better ensures the required harmonization between perceptual representations and central thought and reason. The empirically sensitive realist is well advised, I conclude, to shop around.

References

Churchland, P. (1988). Perceptual plasticity and theoretical neutrality: A reply to Jerry Fodor. *Philosophy of Science, 55*, 167-187.

Churchland, P. (1989). *A neurocomputational perspective*. Cambridge, MA: MIT Press.

Dubois, D. (2000). Categories as acts of meaning: The case of categories in olfaction and audition. *Cognitive Science Quarterly, 1*, 35-68.

Feyerabend, P. (1975). *Against method. Outline of an anarchistic theory of knowledge*. New Jersey: Atlantic Highlands. Humanities Press.

Fodor, J. (1981). The present status of the innateness controversy. In J. Fodor, *Representations* (pp. 257-316). Cambridge, MA: MIT Press.

Fodor, J. (1983). *The modularity of mind. An essay on faculty psychology*. Cambridge, MA: MIT Press.

Fodor, J. (1985). Précis of "The modularity of mind". *Behavioral and Brain Sciences, 8*, 1-42.

Fodor, J. (1988). Perceptual plasticity and theoretical neutrality: A reply to Paul Churchland. *Philosophy of Science, 55*, 188-198.

Fodor, J. (1994). *The elm and the expert*. Cambridge, MA: MIT Press.

Gould, E., Reeves, A. J., Graziano, M. S. A., & Gross, C. G. (1999). Neurogenesis in the neocortex of adult primates. *Science, 286*, 548-552.

Held, R., & Hein, A. (1958). Adaptation of disarranged hand-eye coordination contingent upon re-afferent stimulation. *Perceptual and Motor* Skills, 8, 87-90.

Held, R., & A. Hein (1963). Movement-produced stimulation in the development of visually guided behavior. *Journal of Comparative and Physiological Psychology, 56(5)*, 872-876.

Klinke, R., Kral, A., Heid, S., Tillein, J., & Hartmann, R. (1999). Recruitment of the auditory cortex in congenitally deaf cats by long-term cochlear electrostimulation. *Science, 285*, 1729-1733.

Kuhn T. S. (1962). *The structure of scientific revolutions*. Chicago: Chicago Univ. Press.

Maurer, D., Lewis, T. L., Brent, H. P., & Levin, A. V. (1999). Rapid improvement in the acuity of infants after visual input. *Science, 286*, 108-110.

Miller, J. L. (1987). Mandatory processing in speech perception: A case study. In J. L. Garfield (Ed.), *Modularity in knowledge representation and natural-language understanding* (pp. 309-322). Cambridge, MA: MIT Press.

O'Leary, D. D. M. (1989). Do cortical areas emerge from a protocortex?. *Trends In Neuroscience, 12*, 400-406.

O'Leary, D. D. M. (1997). Areal specialization of the developing neocortex: Differentiation, developmental plasticity and genetic specification. In D. Magnusson et. al. (Eds.), *The lifespan development of individuals: Behavioral, neurobiological, and psychosocial perspectives: A synthesis*. (pp. 23-37). Cambridge: Cambridge Univ. Press.

Quartz, S. (1999). The constructivist brain. *Trends in Cognitive Sciences, 3(2)*, 48-57.

Roe, A. et. al. (1992). Visual projections routed to the auditory pathway in ferrets. *Journal of Neuroscience, 12*, 3651-3664.

Schlagger, B., & O'Leary, D. D. M. (1991). Potential of visual cortex to develop and array of functional units unique to somatosensory cortex. *Science, 252*, 1556-1560.

Sireteanu, R. (1999). Switching on the infant brain. *Science, 286* (5437), 59-61.